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Next Generation Simulation Training for Pararescue Forces

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for December 2010 to February 2014

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14. ABSTRACT

Project efforts resulted in significant technological accomplishments including (1) creation of a simulation execution framework allowing for integration of disparate simulation technologies into a single point of control; (2) advanced integration with Caesar mannequin demonstrating ability to exhibit some control over one or many human patient simulators; (3) demonstration of ability to perform multiple medical trauma procedures on a variety of simulators; (4) creation of virtual casualty characters using DI-Guy software that exhibit correct texturing, motions, and behaviors when imported into the Modern Air Combat Environment (MACE)/ Virtual Reality Scene Generator (VRSG) operational simulator environment; (5) advanced integration and control of scenarios using MACE/VRSG through the development of a new MACE control; (6) development of an environmental proxy providing ability to manage/control electrical devices using power line management technology; (7) creation of high-value simulation training environment allowing pararescuemen to execute a rescue scenario across their full-mission profile; (8) initial capabilities to capture multiple channels of audio, video, and data for After Action Report, and (9) unique solution for communication with role players.

15. SUBJECT TERMS

Pararescuemen, combat search and rescue, pararescue simulation training, mobile simulation unit, distributed interactive simulation, PJ medical training simulation, simulation and training

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1.0 Executive Summary & Phase-II Project Overview

In December 2010, the National Center for Health Care Informatics (NCHCI) was contracted by the Air Force Research Lab (AFRL) and Air Force Special Operations Command (AFSOC) to conduct a research and development effort entitled ***Next Generation Simulation Training for Pararescue Forces***. During a six-month project discovery phase between January 2011 and June 2011, the NCHCI visited a number of academic/research institutions, education training centers, Department of Defense (DoD) simulation training facilities, private Research and Development (R&D) organizations, DoD R&D locations, and the United States Air Force (USAF) Distributed Mission Operations Network (DMON). The NCHCI also interviewed Pararescuemen (PJ) regarding their views on simulation-based training for their mission sets. The NCHCI compiled its findings into a Roadmap document that provides future guidance to the USAF for the integration of simulation training into the mission set of the PJs. This effort provided significant information and data from which the NCHCI developed its Phase II Scope of Work (SOW).

Between July 2011 and November 2013, the NCHCI conducted extensive planning, system design, and analysis as well as the build out of its information technology systems and training infrastructure at its Design and Development Center (DDC) located at The Peak, Inc. in Butte, MT. The NCHCI's Phase II planning and development efforts culminated on November 19-20, 2013 with a PJ Simulation Training Demonstration conducted at its DDC.

In its development of "Next Generation" simulation training technologies, the NCHCI's primary goal was to create a training and testing facility where PJ's could run scenarios across their full mission profile in a highly immersive move, shoot, and communicate battlefield environment. The technologies and capabilities developed under its Phase II SOW, which are described in detail in Section 2, include the following:

- Creation of a DDC at The Peak, Inc.'s facility including a mock Afghan Village, mock HH-60 helo, and a collapsed structure
- Development of system architecture for its Central Simulation Unit (CSU) and Remote Simulation Unit (RSU) configuration
- Creation of a Pararescue Simulation Training Framework (PSTF) that could guide scenario development
- Integration with CAE Healthcare Caesar Medical Mannequin (Caesar) including the development of a custom Software Developers Kit (SDK) for the NCHCI to integrate with Caesar
- Development of a Combat Search and Rescue (CSAR) mission across the PJs full mission profile including briefings, transport, infil, on-target objectives, exfil, transport, and transload
- Incorporation of six (6) medical procedures (as prioritized by AFSOC PJs) into the scenario utilizing the Caesar and live patient actors wearing CutSuit™ and Blast Trousers™ prosthetic devices
- Development of virtual casualties with accurate texturing, movements, and behaviors driven by Boston Dynamics' DI-GUY (DI-GUY) software integrated into the Modern Air Combat Environment (MACE) / Virtual Reality Scene Generator (VRSG) environment
- Implementation of an independent Physiology Model, University of Mississippi Human Model (HumMod), which would drive the physiology of the virtual casualties
- Integration of the NCHCI systems with the USAF's chosen Joint Terminal Attack Controller (JTAC) training environment – MACE/VRSG

- Utilizing Sandia National Laboratories (SNL)'s Umbra Simulation Execution Framework for executing the PJ scenarios
- Use of the OmniScribe After Action Reporting (AAR) system in development by Iowa State University (ISU) including multiple channels of audio, video, and data capture
- Execution of a Simulation Demonstration Training event with PJs to test and evaluate the NCHCI's systems

As reported in Section 2, the results of the NCHCI Phase II activities are very positive. Of the bulleted items listed above, the NCHCI was able to make significant advances in most areas of emphasis during this project phase. The PJ Simulation Demonstration Training event was very successful, and the feedback from the PJs and other participants was very encouraging. While some minor problems occurred during the training events, the NCHCI's systems performed well, and the capabilities proposed under Phase II were demonstrated and evaluated. One significant project failure was the OmniScribe AAR system which is currently in early development by ISU. The NCHCI has determined that this system has not matured to a point where it is ready for integration into a simulation environment that requires the capture of many channels of audio, video, and data. In Phase III, the NCHCI will look for AAR alternatives including Commercial Off The Shelf (COTS) systems or the possible development of an AAR system that meets the needs of the NCHCI.

2.0 Technical Report

The following sections detail the technologies and capabilities developed during the NCHCI Phase II activities of this multi-phase project. Many challenging problems were addressed to provide the PJs with a simulation experience that integrates their move, shoot, and communicate career field tasks with their medical tasks across their full mission profile. The over arching design goal to which we were asked to abide is to *not* construct a new simulator, but rather *add* a PJ "simulation module" to an existing simulation environment currently in use across the USAF, namely the JTAC simulation environment comprised of MACE and VRSG.

2.1 Method

The NCHCI has created an intellectual framework inside of which disparate simulation technologies may be brought together to execute a high-value PJ scenario. Constructing this framework is a significant challenge and being able to modularize the different simulation technology components without sacrificing performance and scalability is of equal difficulty. By leveraging our simulation component vendors, the NCHCI has created a new framework and has demonstrated the ability to integrate disparate simulation technologies with one another and fashion a simulation module designed to execute high-value scenarios.

A deconstructed view of a modern DoD simulation environment is represented in block diagram form in Figure 1. From studying these individual simulation technologies and gaining insight into how each of these might be reconstructed to form a larger intellectual framework within which a knowledge-driven simulation for PJs might take place, the NCHCI was able to begin to fashion a constructive model for how such a framework might look - see Figure 3. Major components of this diagram were used in Phase II activities as a guide in the creation of the solution architecture described in Section 2.3.3.

2.1.1 Design and Development Center

The concept of the NCHCI DDC was developed with two (2) primary goals in mind: (1) the NCHCI needed a facility large enough to accommodate a simulated battlefield environment where PJs could execute rescue scenarios across their full mission profile, and (2) the NCHCI wanted to create a R&D site where many different simulation technologies, devices, hardware, and software could be developed, tested, and evaluated for possible inclusion in future PJ training.

To create its DDC, the NCHCI chose an airport hangar at the Bert Mooney Airport operated by The Peak, Inc. The physical location for the DDC was chosen because of its operational advantages and cost efficiencies. The Peak, Inc. hangar includes a climbing wall, ceiling anchor points for rappelling and fast roping, a rappelling deck, a 32-seat classroom, 6,000 ft^2 of available floor space and immediate access to the Bert Mooney airfield.

The overall goals of the DDC were informed by many of the assumptions obtained through our discovery phase of our project. In particular, there is a need among the PJs to be able to move freely during the execution of their on-target objectives and have enough room to deploy items within their ruck sacks to effectively treat the patients. Further, their desire to execute their full mission profile meant identifying and securing a facility where specific spaces could be transformed to carry out the different elements of their mission profile; from mission brief, to infil, to on-target objectives, to exfil and trans-loading.

2.1.2 Multimodal After Action Reporting

The AAR should detail the actions of the crew during the assignment. Technical, operational, and human elements of crew performance should be discussed as appropriate. Both good and sub-standard performance should be addressed and analyzed. The content of each AAR may vary widely, depending upon the events. AAR systems may include a wide variety of information to be tracked and then later played back to stakeholders related to the training event.

A multimodal simulation environment suitable for the PJs creates a large amount of video, audio, and data that must be recorded, coordinated, and played back in almost any combination for the purposes of a successful AAR.The NCHCI partnered with ISU who is working on the OmniScribe project to capture this multimodal litany of information in a single system.

2.1.3 Assessment and Evaluation

For its phase-II demonstration activities, the NCHCI utilized both assessment and evaluation techniques. PJ's performance was assessed by PJ subject matter experts who were available at the time of the training demonstration to observe their technical, tactical, and medical skills. The NCHCI's simulation training environment was evaluated by all participants including PJs, Subject Matter Expert (SME)s, NCHCI staff, patient actors, and USAF personnel. This evaluation was performed using a survey tool that identified many areas of the simulation environment for feedback from all evaluators.

2.2 Assumptions

The PJs involved in Phase I activities indicated that it is essential to incorporate a number of key elements into the simulation environments in order to gain acceptance of the PJ community and to make the training events meaningful and of high value. Following are essential elements that were incorporated into the simulation environment as prioritized by the PJs:

- PJs must be able to be physically active in the training scenario
- The PJs real weapons, tools, and materials need to be used in the scenarios
- The training needs to incorporate the full mission set of the PJs
- Multiple core training requirements from the Career Field Education and Training Plan (CFETP) must be included in each training event
- PJs need to be able to practice actual tactical, technical, and medical procedures during the simulation
- The highest reality simulated patients should be incorporated (patient actors in cut suits, durable & rugged mannequins)
- The Virtual Reality (VR) aspects of the simulation need to be crisp (cannot be “cheesy” or “too fake”)
- The environment needs to focus on both individual and team training
- External stimuli (sound, smells, lighting, etc.) all need to be incorporated to simulate an actual battlefield environment
- Need to focus on special aspects of the personnel recovery mission and include simulations such as rock walls, aircraft or vehicle mock-ups (for extrications), collapsed structures, Mobile Military Operations on Urban Terrain (MOUT) environments, etc.

2.3 Procedures

2.3.1 PSTF

The NCHCI made significant progress in the development of a software tool designed to simplify the process of creating and scheduling training scenarios for the PJs.

The PSTF is a software tool used to plan an integrated training event within the PSTF execution framework.

2.3.2 Pararescue Content Creation

High-Value PJ Scenario The high-value PJ scenario developed by NCHCI consists of two (2) components: a Simulated Clinical Experience (SCE) that runs on Caesar and a threat environment mission that runs on the MACE / VRSG simulation environments. Together, both of these components implement a high-value scenario for the PJs.

The SCE simulates the following injuries on the Caesar platform (1) Amputated Right Leg Below the Knee; (2) Shrapnel Injury to Left Forearm; (3) Crushed Chest with Tension Right Pneumothorax; and (4) Hypovolmetric Shock from Blood Loss.

The following interventions can be performed on Caesar to address these injuries (1) Hemostatic Dressing; (2) Tourniquet Application; (3) Treat Wounds; (4) Needle Thoracentesis; (5) Administer Medications; and (6) IV/IO Administration.

The threat environment mission delivers the following elements (1) A pre-mission briefing pre-scripted; (2) A pre-determined 15-minute flight from a forward operating base near Kabul, Afghanistan to a village south of Kabul; (3) Infiltration by a helo with PJs dismounting the helo at ground level; (4) Virtual Improvised Explosive Device (IED) injuring a US soldier (demonstrating DI-GUY capabilities) who moves from the virtual world and reappears as Caesar; (5) MACE environment can be customized by local operators to include friendly and enemy combatants, other assets as desired (vehicles, weapons, aircraft, etc); call for fire elements with supplied peripheral equipment; (6) PJs are required to treat and package the casualty; and (7) A pre-determined 15-minute return flight from the village south of Kabul back to the forward operating base near Kabul, Afghanistan.

Combat Casualty Characters The NCHCI has created three (3) combat casualty characters consisting of two (2) blue force entities and one (1) civilian. These characters are analogs to stock (uninjured) characters. These characters have the injuries as shown in Table 1.

Table 1: Combat Casualty Character Specifications

Character	Type	Injuries
Soldier-1	Blue Force	bleeding wound to neck, compromised airway; penetrating wound to chest with hemopneumothorax; open abdominal wound with partial evisceration
Soldier-2	Blue Force	inguinal injury - large open groin wound bleeding profusely
Female Civilian	Civilian	Large open bleeding wound to face and neck

These characters were created in AutoDesk 3D Studio Max and imported into DI-GUY. Once inside DI-GUY, these characters' texture maps were changed to reflect the look of their injuries. Within the DI-GUY Scenario (Boston Dynamics' Image Generator (IG)), there is a special effects generator which would allow for profuse bleeding and other effects. These are, however, not supported in the VRSG IG.

Characters were then imported into the VRSG environment and entity mapped to alternate character forms of the standard soldier and civilian entities. The DI-GUY Boston Dynamics' Life Form Server (LFS) was then used to control these casualty combat characters within VRSG according to a physiology model.

2.3.3 Compute Infrastructure CSU / RSU / MSU

The implementation of the high-level constructive design shown in Figure 3 has been realized in an architecture whereby there is a single CSU connected to multiple RSUs. Each RSU provides an *integration hub* into the multimodal simulation system.

RSU: The RSU acts as an integration hub for the solution architecture and consists of the following core components:

- Threat Simulation Environment (MACE / VRSG)
- Medical Simulation Environment (Caesar)
- Environmental Proxy to control Lighting and Special Effects

- Audio Generation for 3D Sound
- Audio, Video and Data Capture for AAR
- Two-Way Communications
- Storage forAAR and codebase
- Networking Hardware linking all RSU components

All of these components can be bundled together in a single RSU, or only those components required; the entire system is completely modular.

CSU: The CSU is where all the complex computation is carried out and it is broken down into the following roles:

Umbra Orchestration Layer - Responsible for coordinating the execution of the multimodal simulation environment

Umbra Transcoding Layer - Responsible for communications between the CSU and RSUs through a pluggable gateway model

Umbra Model Processing Layer - Responsible for executing models such as physiology, weather, physics, ballistics, etc.; only the physiology model (HumMod) was implemented during this phase

During Phase II, a single RSU was connected to a single CSU. The CSU ran on five (5) cluster nodes of an IBM1350 cluster located at the Montana Economic Revitalization & Development Institute (MERDI) data center while the RSU was placed seven (7) miles away at The PEAK. Should additional RSUs be connected to the system, blocks of five (5) cluster nodes could be used to instantiate multiple simulation environments on the single cluster up to the maximum number of compute nodes in the cluster; which was a total of 42 compute nodes supporting up to 8 RSUs.

Mobile Simulation Unit (MSU): The MSU is an attempt to use virtualization technologies to collapse key RSU and CSU components into a single mobile simulation module that can be connected into an existing JTAC simulation environment and augment such an environment with the necessary simulation technologies to implement a Personnel Recovery Training Rehearsal System (PR TRS).

A version of the MSU is shown in Figure 5 and consists of the components shown in Table 2.

2.3.4 Simulation Environment

Modifications to the hangar were made as follows:

- A man-rated hoist was installed for hoisting operations. This involved structural modifications to the building's truss and ceiling structure and the physical installation of the hoist in a fixed location. The hoist, manufactured by Skyclimber, was load tested and all safety systems were tested.
- Electrical upgrades to accommodate electrical supply where needed for various equipment.
- Network wiring from the location of the Remote Simulation Unit (located in the classroom) to all control points within the training environment (approximately 30 network drops).

Table 2: MSU Components

Server	Purpose	Type	IP Address
Svr-1	Threat Environment MACE / VRSG / DI-GUY Render	Bare Metal	10.200.102.130/24
Svr-2:0	Umbra Framework	Host (Hyper-V)	10.200.102.131/24
Svr-2:1	Microsoft Standard Server 2012 (AD, DNS)	VM	10.200.102.132/24
Svr-2:2	Microsoft Storage Server 2012 (iSCSI)	VM	10.200.102.133/24
Svr-2:3	Umbra Model Processing Layer	VM	10.200.102.134/24
Svr-2:4	Umbra Orchestration Layer	VM	10.200.102.135/24
WAP	Cisco Wireless AP for Caesar Network	Network	10.200.102.136/24
GbE	Gigabit Ethernet Switch for Interconnect	Network	
GPU	GPU Expander (PCI-e Expansion Bus for Svr-1)	PCI-e	

- A swing arm was installed to accommodate a 65" LCD display located approximately 8' from the door of the helo positioned approximately 20' AGL.
- The RSU was placed in the classroom and all networking wiring to the DDC was terminated at the RSU. Additional equipment installed included:
  1. seven (7) video cameras to capture video throughout the training area including the classroom and the helo,
  2. a 16'x9' rear projected display and a large lumen data projector,
  3. a 7.1 channel surround sound stereo system including separate zones for the main village and the helo,
  4. area microphones in both the classroom and the village area to capture ambient noises and communications,
  5. a wireless access point for communications with the Caesar, and
  6. Insteon controls on all lighting and the helo fans so that control over these could be executed at the control panel.

MOUT A mock Afghan village was constructed and placed in the hangar. This village included 12 individual 8'x8' panels that were textured to resemble the façade of an Afghan hut. Four of these panels were used to construct an 8'x8' room where two live patient actors were positioned during the scenarios. The village also included textural details such as awnings, a fruit stand, a cart, bicycles, and other textural elements that helped improve the realism of the village.

A collapsed structure was built using large pieces of concrete construction debris. One very large piece of the concrete was modified with lifting anchors and chains so it could be easily lifted and placed on the Caesar.

A mock HH-60 helicopter was constructed and placed on the hangar rappelling deck (approximately 20' above the floor of the hangar). The helicopter was equipped with sliding doors on both sides of the mock helo, internal speakers to simulate rotor noise, and large industrial, high velocity fans mounted above the helo to simulate rotor wash. An anchor point was installed to accommodate a fast rope outside the doors of the helo. Anchors were installed in the floor of the helo to support a rope ladder.

Environmental Controls The solution architecture is able to control environmental elements through the use of an NCHCI authored environmental proxy. This software leverages the Insteon hardware which consists of a Power Line Communications (PLC) modem connected to one of the RSU compute blades and is then plugged into a power outlet. Other Insteon modules are then connected to a power outlet and device under control are then connected to the module. The environmental proxy sends commands to the Insteon modem which then converts these commands into the PLC protocol that gets sent over the power cabling as a network. The corresponding module(s) then respond to the command and perform one or more actions.

The NCHCI used the environmental proxy to control lighting in the MOUT area at The PEAK, as well as to control larger powerful blowers that were placed above the mock HH-60 body to simulate rotor wash. The environmental proxy acts as a pluggable gateway module to the Umbra Orchestration Layer.

Audio Processing The VRSG IG used in the thread simulation environment is based on the Microsoft DirectX suite of protocols. One of these protocols implements DirectSound which is a 3D sound generation technology that can then leverage a 5.1 or 7.1 surround sound processor to create a soundscape that is consistent with the landscape produced by the IG. The NCHCI selected the Marantz AV7005 sound processor and then split the zones; creating a single zone for the main on-target areas, and a single zone for the helo area. These two zones were fed DirectSound 3D audio to create a soundscape for the environment.

The sound produced was the stock sounds bundled with the MACE / VRSG software and no additional work was performed to “shape” the sounds to accommodate the specific PJ threat environment created. This could certainly be performed and become part of a higher-fidelity scenario in subsequent phases. Further, the sound output hardware was relatively low-powered for producing the kinds of sounds and percussive-feel associated with a threat environment; this too could be enhanced in subsequent phases.

2.3.5 A/V/D Capture

The AAR capabilities sought for this project require a large amount of audio, video, and data capture to be accomplished. These systems are described below:

Audio Capture Audio capture for our solution architecture implemented at The PEAK broke down into the following categories:

Radio Channels Harris Radio provided the project with three (3) PJ radios each of which was integrated into the RSU. One channel was used to capture PJ team communications, one for the Tactical Operations Center (TOC) communications, and one for communications with the helo.

Patient Actors There were three (3) patient actors in the scenario that played out at The PEAK. Not only did the system need to capture the audio from each of these patient actors, but the medical SME also needed to provide these actors instructions during the execution of the scenario. This two-way communication was accomplished by utilizing an open source Voice over the Internet Protocol (VoIP) soft-switch, VoIP clients on Apple iPOD Touch devices, and Inkeeper interface units to link from the soft-switch to the audio capture device. This allowed for two-way communication to be established.

Boundary Areas In order to capture the audio associated with the briefings and the general audio of the main on-target area, boundary microphones were used with high-gain pickups to allow for excellent sound capture quality. These were interfaces into the capture device and recorded on their own audio tracks.

All audio devices were interfaced to a US-TASCAM audio capture device connected to one of the RSU blades through a Universal Serial Bus (USB) 3.0 connection.

Video Capture Video capture was accomplished through the use of H.264 capable network video cameras. These were inexpensive and not of the best quality, generating only 720p resolution and needing to be placed far away from the areas of interest. As a result, it is difficult to use the video to effect the medical components of AAR as it is difficult to visually determine the finer manipulations associated with the performance of medical procedures.

For all other activities - tactical, technical - the imagery was of sufficient quality and there were enough cameras (7 total) placed to provide clear views of all areas of interest.

Data Capture In addition to the audio and video elements of the simulation, data elements also need to captured. For our purposes, these broke down into the simulation protocol data, and the physiology data as described below:

Simulation Protocols The only simulation protocol used in Phase II of the project is Distributed Interactive Simulation (DIS), however High-Level Architecture (HLA) could just as easily been added to the Umbra Transcoding Layer to incorporate an HLA driven simulation environment. The discrete events associated with the execution of the scenario would appear within these simulation protocols and these events should be recorded for AAR to correlated activities happening in the synthetic environment with those activities being performed by the trainees.

Physiology Data Physiology data was able to be extracted (in real-time) from the Caesar platform through the use of their SDK. In addition, real-time data, and pre-processed physiology data could be extracted through the HumMod model solver that is driving the virtual combat casualty characters. All of this physiology data could then be recorded for AAR and correlated on playback with the actions being performed by the trainees.

Additional data can be recorded as well. Some of these potential data sources are described above in Section 2.1.2.

2.4 Results

2.4.1 Simulated Demonstration Training

On November 19-20, 2013, the NCHCI conducted PJ Simulation Training Demonstration at the DDC. This event was the culmination of many months of planning, preparation, system development, and the build-out of the training environment at the DDC. Two PJs from the 48 Rescue Squadron (RQS) participated in the training, and two senior PJs from AFSOC were there to observe the demonstration. Additionally, representatives from AFRL, AFSOC, the Air Force Medical Modeling and Simulation Training (AFMMAST) program, and Wyle were on hand to observe the training demonstration.

For the training, the NCHCI executed a single CSAR scenario each day and the scenarios were executed as follows:

1. All Information Technology (IT) systems and simulation components were set up and readied for scenario execution.

2. The Caesar was moulaged, charged, and placed under the collapsed structure.

3. The PJs were notified that an incident had occurred and were called into a briefing in the hangar classroom which was set-up with maps, charts, and handouts for the briefing.

4. Role players conducted a mission brief that included the mission details, intel, medical, and weather briefs. PJs were provided maps of Afghanistan, the area of operation, the incident site, and a weather map. The helo was spun up from the control station (helo rotor sounds and the fans were turned on). The two displays (TV and Rear Projection Screen) were turned on and displayed (MACE/VRSG) the Point of View (POV) from the helo looking out at Bagram Air Field.

5. PJs exited the briefing room, finished packing their rucks, and loaded onto the mock helo with a flight engineer (role player).

6. Upon their ready command, the helo was launched from the MACE script control panel and the PJs were transported on a virtual flight path from Bagram Air Field to a small village south of Kabul. The scripted flight ended with a fly over of the village and then into a hover position where the PJs could fast rope into the village.

7. The PJs infilled by fast rope and entered the mock Afghan Village. Lighting and sound were switched on from the execution framework. The virtual display was switched using the execution framework to a POV from the center of the Afghan village. The helo was sent into a flight orbit from the MACE script control panel. The Caesar SCE was launched using the simulation execution framework.

8. Upon entering the village, the PJs discovered Caesar trapped under a collapsed structure and immediately began treatment. Moments later, an IED was launched from the MACE Script Control Panel injuring three virtual characters (rendered by DI-GUY). The virtual characters moved from the Point of Injury (POI) to the edges of the screen and out of view where they were replaced by live patient actors (one soldier wearing a Cut Suit™, one soldier wearing Blast Trousers™, and one female Afghan civilian). Communications with the PJs occurred using Harris radios and three frequencies were captured for AAR, comms with the patient actors occurred over Session Initiation Protocol (SIP) enabled iPod devices, video was captured from all cameras during the entire scenario, and data from Caesar was captured.

9. PJs treated and packaged the casualties. Caesar's bleeding channels were controlled through the execution framework. When treatment was completed, the PJs called for ex-fill and scripts were executed to bring the helo back, start up the sounds and fans, and the virtual display was switched back to the helo POV. One casualty was hoisted into the helo but a mechanical problem with the hoist prohibited any further hoisting activities. Scripts were executed to have the helo return to Bagram Air Field at which time the PJs continued treatment. The scenario ended during transport.

10. Following the scenarios, the NCHCI conducted debriefing sessions where input was received from all participants and observers. Everyone present was asked to complete a survey to evaluate the elements of the simulation event.

2.4.2 Evaluation

A critical element of the PJ simulation training exercise conducted in Butte, Montana on November 18, 19, and 20, 2013 was the evaluation component. A variety of different mechanisms were employed for gathering data to assist in the process of judging how well the session/program was delivered and how effective it was in meeting the needs of the trainees. Data gathered will also provide valuable information to guide any revisions to the program that may be required in order to effectively meet the ongoing needs of the learners. The different mechanisms employed for gathering data included:

- Verbal feedback
  - Obtained through two debriefing sessions conducted immediately after training.
- Written feedback
  - Obtained through a web-based survey tool (SurveyMonkey)

Data Analysis: Analysis of the information gathered is more heavily slanted towards the data gathered through the debriefing sessions due to the fact that there was a greater level of participation in the debriefings as well as the fact that participation in the written survey was heavily slanted towards those that played a development role and relatively lacking in participation from the customer and end users. An ideal data summary and reporting structure is precluded by the dictated maximum length of this report and as a result, the information obtained through the data gathering mechanisms is, out of the need for brevity, being detailed in a classical Strengths, Weatknesses, Opportunities, Threats (SWOT) structure.

STRENGTHS: Identified strengths of the simulation training include:

- Training scenario was relevant to PJ Trainee
- Simulation experience made PJ Trainees feel uncomfortable and stressed
- Context relates well and realistically to PJ Trainee
- Ability to move around within scenario as well as to use own equipment
- Scenario was very challenging (especially for two PJs)
- Village, helicopter mock-up, blast trousers, collapsed structure and moulage added considerable realism (both appearance and function) to the scenario
- Cut Suit™ added to realism of scenario relative to the function of the suit (but not appearance)
- Hoist component (when functioning)

WEAKNESSES: Identified weaknesses of the simulation training include:

- Communications (need to be more active, need more than one person giving updates, everyone not connected to other scenario participants)
- Caesar (mechanical durability poor, drop durability poor, could not feel pulses, screams too much, dropped off network)
- Cut Suit™ anatomy confusing
- PJs tend to migrate away from mannequins and gravitate toward live bodies.
- Audio elements (machine gun fire got stuck, sounds not spatially correct or directive, explosions lacked depth and percussion, not enough normal background noise)
- Virtual elements (PJs were not drawn into virtual environment, virtual entities did not react appropriately to live participant actions)
- Mechanics of the simulation components were not optimal
- Number and kind of support actors were not appropriate (i.e., security forces, PJ Team Leader, Ground Force Commander, Combat Rescue Officer, etc.)
- Exercise area not large enough

OPPORTUNITIES: Identified areas where improvements could be made:

- Audio – add additional spatially correct audio elements
  - background noises such as doors opening and closing, the wind, voices
  - blasts and small arms fire
- Communications
  - connect all participants
  - connect all scenario controllers
  - have more than one person giving updates or incorporate audio chatter soundtrack with varying voices
- Virtual – incorporate simulation elements that will draw participants into the virtual space
  - two-way hit detection
  - sensory feedback
- Visual and Smell
  - add smoke generators
  - add smell generators

THREATS: Identified areas that would threaten the continued development of simulation prototype

- Lack of perceived value by PJs
- Elimination or cutback of funding
- Lack of program champion

2.5 Discussion

The NCHCI's Phase II efforts have resulted in significant technological accomplishments while advancing the goal of creating a simulated training environment that can meet the training objectives of the PJs. In particular, the NCHCI points to the following project accomplishments:

- Creation of a simulation execution framework which allows the integration of many disparate simulation technologies into a single point of control
- Development and demonstration of a CSU/RSU architecture - and a standalone MSU
- Advanced integration with the Caesar demonstrating the ability to exhibit some control over one or many Human Patient Simulator (HPS)
- Demonstration of the ability to perform multiple medical trauma procedures on the Caesar, Cut Suit™ and Blast Trouser™ simulators
- Creation of virtual casualty characters using DI-GUY software that exhibit correct texturing, motions, and behaviors when imported into the MACE / VRSG environment
- Advanced integration and control of scenarios using MACE / VRSG through the development of new MACE controls
- Development of an environment proxy that provides the simulation operator with the ability to easily manage and control electrical devices (lighting, fans, etc.) using power line management technology
- Creation of a high-value simulation training environment that allows the PJs to execute a rescue scenario across their full-mission profile
- Initial capabilities to capture multiple channels of audio, video, and data for AAR
- Unique and creative solution for communication with role players during a simulation exercise

The NCHCI acknowledges the assistance of the AFRL, AFSOC, and the AFMMAST program in providing guidance and oversight to this project. Additionally, the NCHCI acknowledges the work of its project partners who made significant contributions to this project including substantial in-kind support.

Appendix A List of Tables

Appendix B List of Figures

Appendix C List of Acronyms

AAR	After Action Reporting. 2, 3, 6, 8–10, 13
AFMMAST	Air Force Medical Modeling and Simulation Training. 9, 13
AFRL	Air Force Research Lab. 1, 9, 13
AFSOC	Air Force Special Operations Command. 1, 9, 13
Caesar	CAE Healthcare Caesar Medical Mannequin. 1, 4, 5, 7, 9, 10, 12, 13
CFETP	Career Field Education and Training Plan. 4
COTS	Commercial Off The Shelf. 2
CSAR	Combat Search and Rescue. 1, 10
CSU	Central Simulation Unit. 1, 5, 6, 13
DDC	Design and Development Center. 1–3, 7, 9
DI-GUY	Boston Dynamics' DI-GUY. 1, 4, 5, 10, 13
DIS	Distributed Interactive Simulation. 9
DMON	Distributed Mission Operations Network. 1
DoD	Department of Defense. 1, 2
HLA	High-Level Architecture. 9
HPS	Human Patient Simulator. 13
HumMod	University of Mississippi Human Model. 1, 6, 9
IED	Improvised Explosive Device. 4, 10
IG	Image Generator. 5, 8
ISU	Iowa State University. 2, 3
IT	Information Technology. 10
JTAC	Joint Terminal Attack Controller. 1, 2, 6
LFS	Boston Dynamics' Life Form Server. 5
MACE	Modern Air Combat Environment. 1, 2, 4, 5, 8, 10, 13
MERDI	Montana Economic Revitalization & Development Institute. 6

MOUT	Mobile Military Operations on Urban Terrain. 4, 8
MSU	Mobile Simulation Unit. 6, 13
NCHCI	National Center for Health Care Informatics. 1–5, 8–10, 13
PJ	Pararescuemen. 1–4, 8–13
PLC	Power Line Communications. 8
POI	Point of Injury. 10
POV	Point of View. 10
PR TRS	Personnel Recovery Training Rehearsal System. 6
PSTF	Pararescue Simulation Training Framework. 1, 4
R&D	Research and Development. 1, 2
RQS	Rescue Squadron. 9
RSU	Remote Simulation Unit. 1, 5–9, 13
SCE	Simulated Clinical Experience. 4, 10
SDK	Software Developers Kit. 1, 9
SIP	Session Initiation Protocol. 10
SME	Subject Matter Expert. 3, 8
SNL	Sandia National Laboratories. 1
SOW	Scope of Work. 1
SWOT	Strengths, Weatknesses, Opportunities, Threats. 11
TOC	Tactical Operations Center. 8
USAF	United States Air Force. 1–3
USB	Universal Serial Bus. 9
VoIP	Voice over the Internet Protocol. 8
VR	Virtual Reality. 4
VRSG	Virtual Reality Scene Generator. 1, 2, 4, 5, 8, 10, 13

Figure 1: NCHCI Simulation Framework Block Diagram

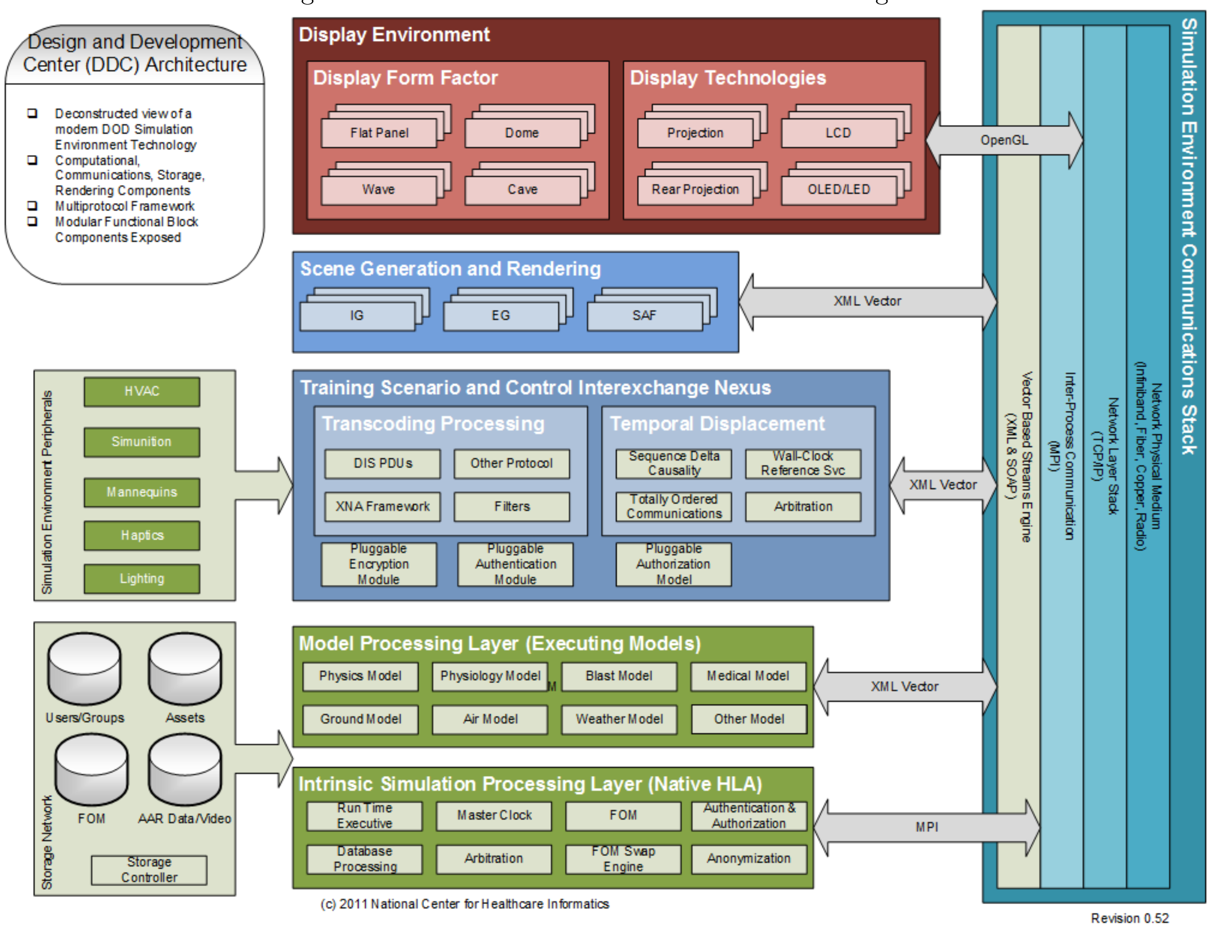


Figure 2: DDC Floor Plan

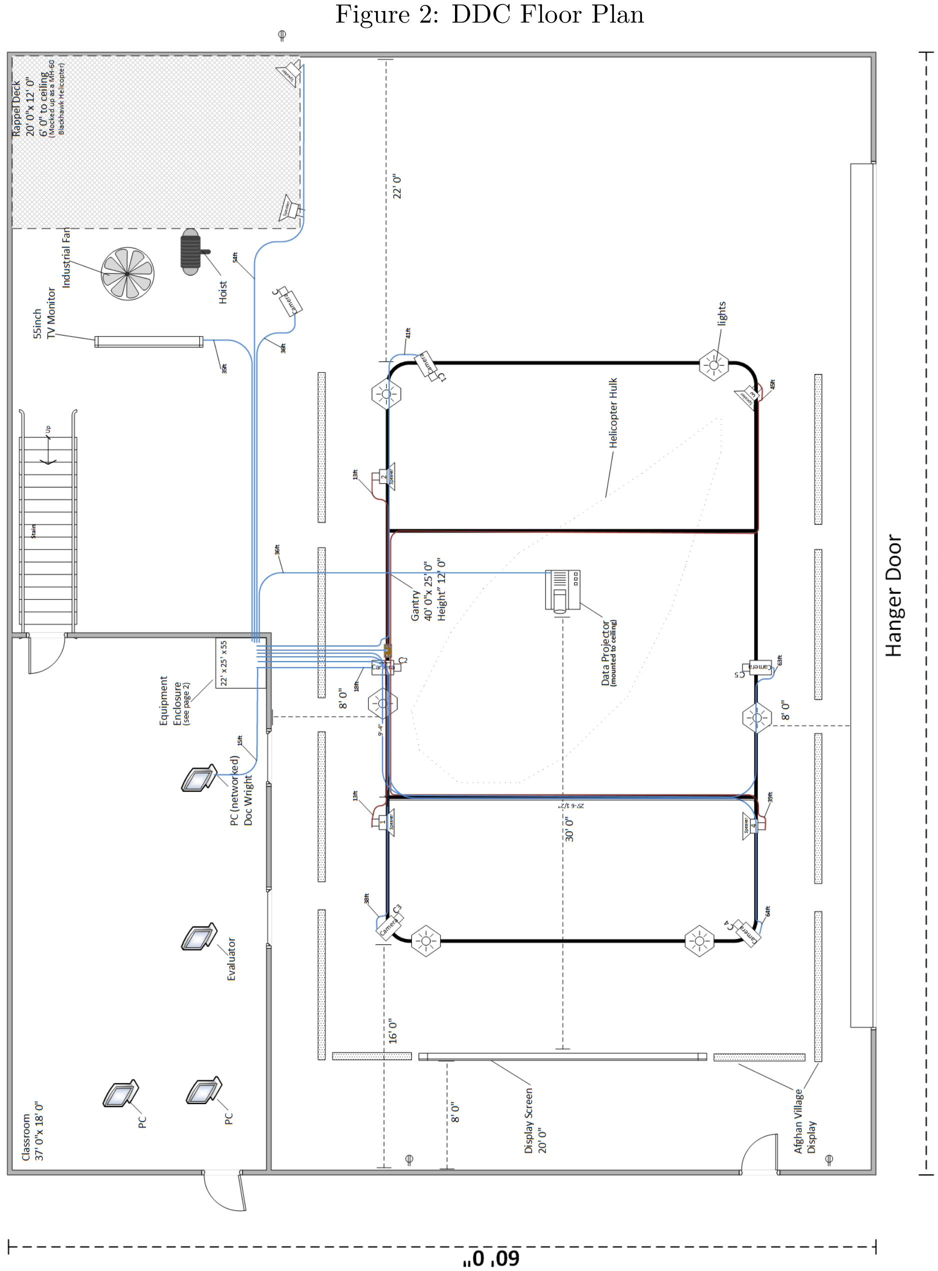


Figure 3: NCHCI Constructive Framework Model

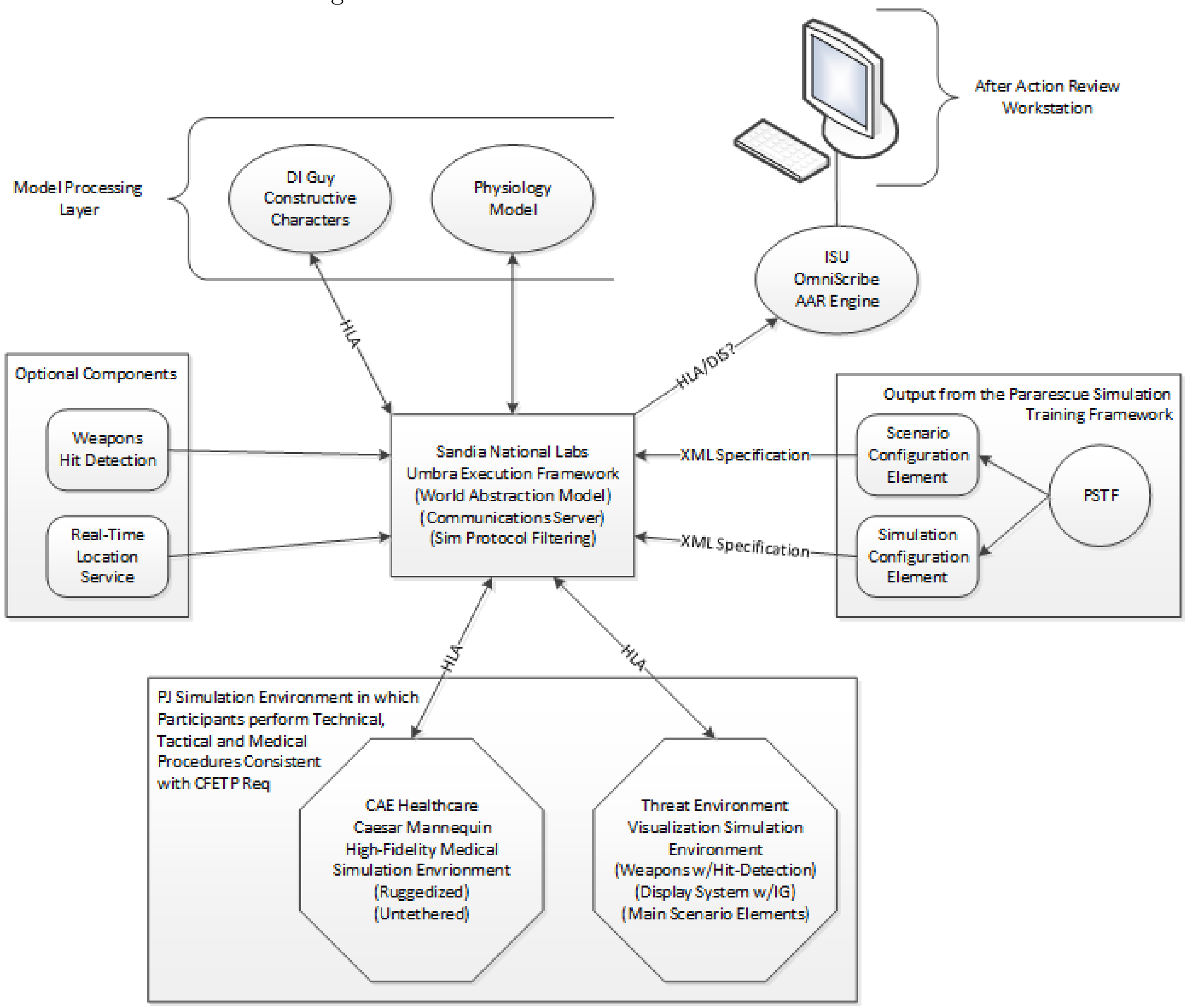


Figure 4: Solution Architecture

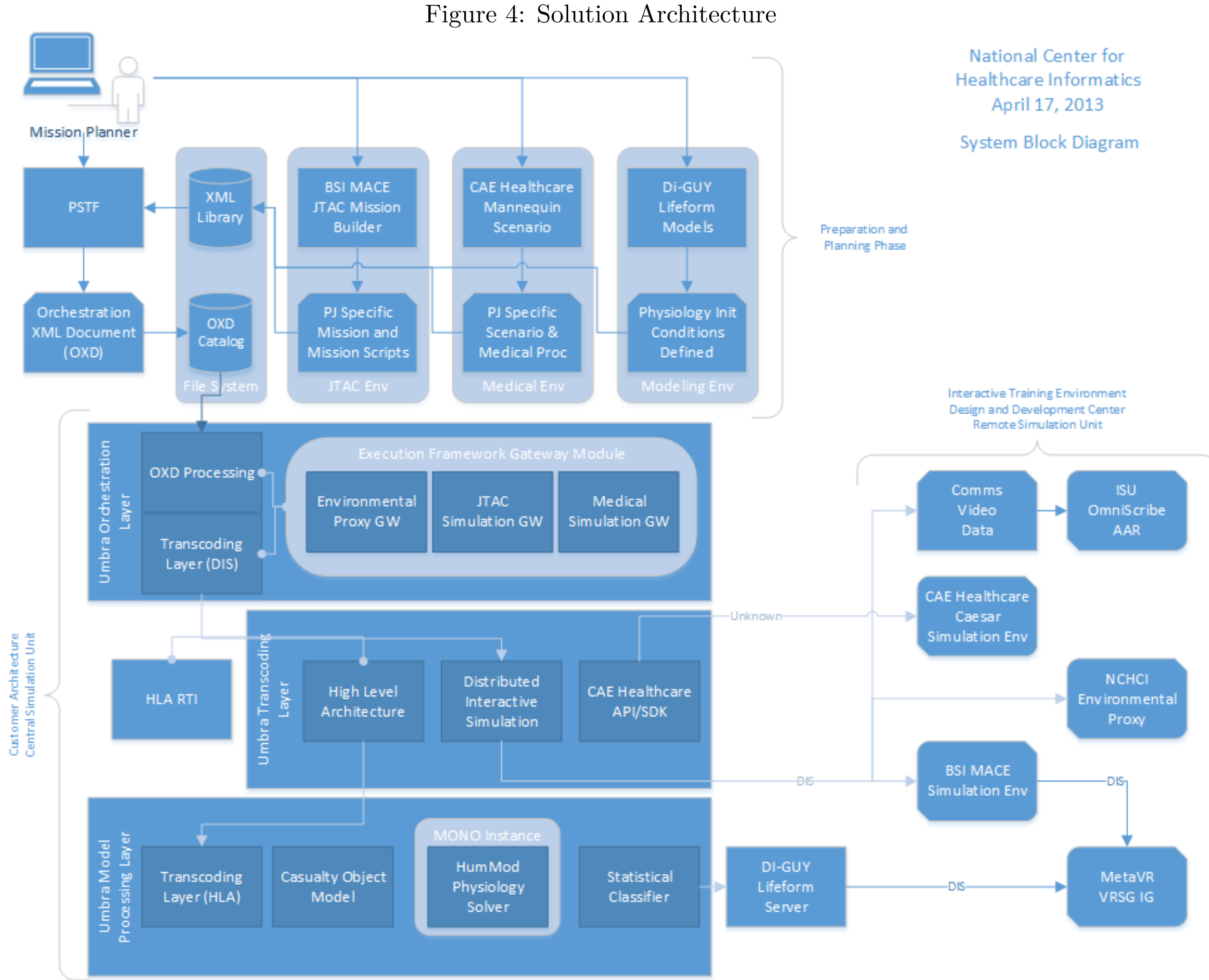
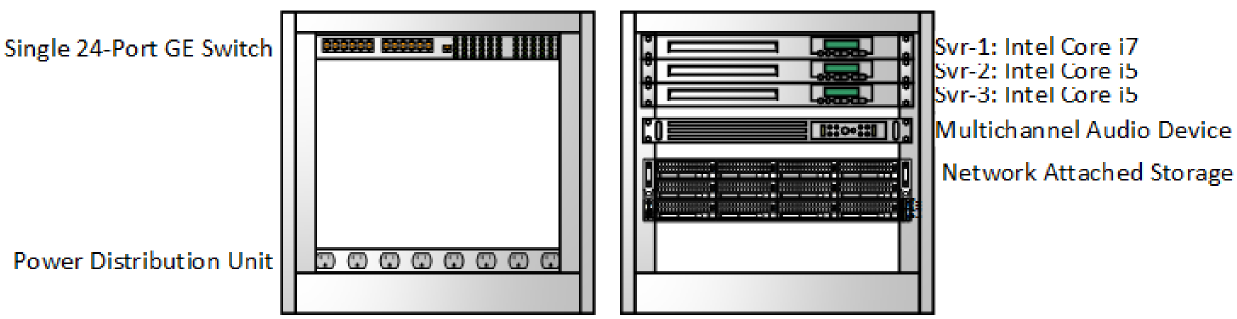
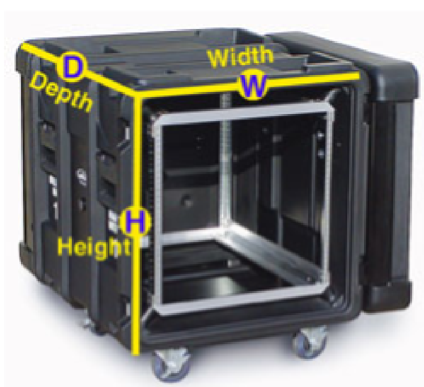


Figure 5: Mobile Simulation Unit





Inside Dimensions		Outside Dimensions	
Height	17.75"	Height	27.62"
Width	19"	Width	26.5"
Depth	28.75"	Depth	43"
Lid Depth	4.5"		
Rack Units	10U		
Weight	96lbs		